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Issues concerning the implementation of the CCS Directive in the Netherlands

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Abstract

In June 2009, the EU Directive on the Geological Storage of Carbon Dioxide entered into force. The European Member states are obliged to transpose the directive in their national legislations no later than 25 June 2011. The EU legislator has applied a regime of minimum harmonisation when drafting the CCS Directive, amongst others to achieve that an agreement could be reached on the CCS Directive by a majority of Member States. In other words; Member States have considerable discretionary powers while implementing the Directive. The CO2 Storage Directive is mainly transposed into Dutch legislation by means of adaptation of the Dutch Mining Act. There are, however, still some issues in the implementation of this directive that need further clarification. The way these issues are addressed may impact the deployment of large-scale CO2 capture and storage (CCS) in the Netherlands and Europe.

Keywords: Carbon dioxide capture and storage; legislation; implementation; site selection; liability; Netherlands; European Union.

1. Introduction

In June 2009 the European Directive on the Geological Storage of Carbon Dioxide [1] (Directive 2009/31/EC, hereafter CCS Directive)) entered into force. It obliges Member States to transpose the Directive in their national law no later than June 25, 2011. In the Netherlands the CCS Directive will be implemented by means of amending the Dutch Mining Act [2] (Mijnbouwwet).

The EU legislator has applied a regime of minimum harmonization when drafting the CCS Directive, amongst others to achieve that an agreement could be reached on the CCS Directive by a majority of Member States. Minimum harmonization means that the Directive provides for a minimum set of rules and that Member States may decide to issue more stringent rules on national level. In other words; Member States have considerable discretionary powers while implementing the Directive. In addition, Member States may still issue additional rules governing CCS. This may pose two kinds of problems:

- First, the way in which Member States apply their discretionary powers may negatively impact the development of CCS in individual Member States.
- Second, it is possible that requirements in the Directive are implemented in a more rigorous manner in one Member State than in another Member State. This can lead to the situation that investors' propensity to invest in CCS is likely to differ substantially between Member States (there will be no level playing field).

Since storage costs will be passed through to power plants with CO_2 capture installations, (expected) electricity generation costs between Member States are affected differently and investments in new fossil fuelled generators might

be cancelled. The level playing field between storage operators in different Member States is likely to be distorted, which may decrease overall social welfare in Europe.

There are still a number of issues regarding the implementation of the EU CCS Directive that need further clarification, and the way these issues are addressed may impact the deployment of large-scale CCS in the Netherlands and Europe. This paper analyses several of these issues, and aims at providing possible pathways and recommendations on how to resolve them. These recommendations concentrate on actions to be taken by governments. The issues can be classified into three categories:

- Issues for which the EU legislator has indicated that further EU guidelines will be presented (such as composition of the CO_2 stream, transfer of responsibility, financial mechanism, monitoring);.
- Issues for which no such guidance is indicated and Member States have full discretionary powers (such as selection of storage sites, Third Party Access, supervisory structure); and
- Issues relevant for the development of CCS but not regulated in the Directive and thus totally governed by national law (such as long-term liability).

Three of these issues, one of each category, are researched in more detail in this report: the safe selection of storage sites, the composition of the CO_2 stream and long-term liability.

2. Issue #1: Lack of clear standards for safe site selection and the share of CO_2 that might be at risk to leak from a storage site

The CCS Directive mentions that:

- The suitability of a geological formation for CO_2 storage has to be assessed through a process of characterization and assessment; and;
- A storage site may only be selected if the likelihood of leakage is not significant, and risks for human health and environment are not significant.

It is not yet clear when there is a significant risk of leakage, and if this risk exists, whether environmental or health risks are significant as well. Furthermore, the Directive does not include clear standards for the share of CO_2 that might be at risk to leak from a storage site. Therefore, there is fear for a too strict interpretation of the Directive by some Member States, thereby making CO_2 storage too costly [3].

One possibility to take away these concerns, would be to include a maximum probabilistic level of leakage in European legislation. However, currently, no quantitative standards can be set for safe site selection due to lack of data on probabilities of CO_2 leakage. Therefore, we suggest to declare a storage site unsafe if:

- No clear-cut reason can be found for simulations of the storage site producing CO_2 leakage;
- A clear-cut reason can be found, with essential parameters being highly uncertain..

If none of the simulations produces leakage, the site might be deemed safe. This solution should preferably be implemented at the European level since all countries face the same issue.

3. Issue #2: Unclear requirements on composition of the CO_2 stream and impacts of 'overwhelmingly CO_2'

Regarding the composition of the CO_2 stream the CCS states: 'A CO_2 stream shall consist overwhelmingly of carbon dioxide'. In addition, the CO_2 stream should not pose a risk to human health, the environment or to the integrity of the CO_2 storage site or transport infrastructure. When HSE requirements and requirements from CO_2 transport and storage systems are compared with the likely compositions of the product streams of the various CO_2 capture processes that are currently considered (Table 1), it is concluded that current CO2 capture processes are well capable of fulfilling the requirements from of meeting restrictions regarding transport and storage systems, as well as health, safety & environment (HSE) considerations [4, 5, 6]. At different stages in the process cleaning techniques will have to be applied. The main motivation for this additional purification will be the prevention of corrosion and two-phase flow formation. Since these concerns are of direct interest to the operators of the capture, compression and transport facilities, the requirements in the CCS directive do not necessarily have to be made more specific in this respect. Table 2 presents CO_2 quality recommendations from The Dynamis project [7].

Table 1: Indication of the concentrations for different components found in the product streams of the three main capture processes [4], [5], [6].

Component (mole %)	Post-combustion Capture (amine absorption)		Pre-combustion Capture (IGCC & physical absorption)		Oxyfuel (coal)	
	Process	Cleaned	Process	Cleaned	Process	Cleaned
CO_2 purity	98.6	99.5	95	99.9	89.4	99.2
H_2O	0.14 - 1.4	<.14	0.14	<0.14	0.14	<0.14

Argon	.02	-	.05	-	0.6 – 5.7	0.045
N_2	0.021	-	0.03	-	0.6 - 5	0.3
O_2	0.003	-	< 0.003	?	0.6 - 5	0.3
H_2	-	-	1.7 - 5	0.1	-	-
SO_2	0.001 (10 ppm)	-	-	-	47 ppm -760 ppm	57 ppm
Nox	20 ppm	20 ppm	< 20 ppm	< 20 ppm	2000 ppm	20 ppm
H_2S	-	-	1-100 ppm	-	-	-
CH_4			350 ppm	-		
A wide range of trace components can be present at infinitesimal quantities						

Table 2: DYNAMIS CO_2 quality recommendations

Component	Concentration	Limitation
H_2O	500 ppm	Technical, below solubility limit of H_2O in CO_2
H_2S	200 ppm	Health & safety considerations
CO	2.000 ppm	Health & safety considerations
O_2	Aquifer < 4 vol%* EOR 100-1000 ppm	Technical, range for EOR because lack of practical experiments on effect underground
CH_4	Aquifer < 4 vol%* EOR < 2 vol%	As proposed in ENCAP project
N_2	< 4 vol%*	As proposed in ENCAP project
Ar	< 4 vol%*	As proposed in ENCAP project
H_2	< 4 vol%*	Further reduction of H_2 is recommended because of its energy content
Sox	100 ppm	Health & safety considerations
Nox	100 ppm	Health & safety considerations
CO_2	> 95.5 %	Balanced with other compound in CO_2

4. Issue #3: Lack of clear criteria for transfer of responsibility of CO_2 storage sites

The CCS Directive requires that a minimum period has elapsed before the responsibility for the storage site can be shifted from the operator to the competent authority. In principle the length of the required minimum period is 20 years, but national competent authorities are allowed to reduce the period before transfer of responsibility can take place. This is the case, when the authority is convinced that the stored CO_2 will be completely and permanently contained before the end of a shorter period.

The current policy creates the chance that when one Member State let short-term (industry) interests prevail to long-term climate and security interests and consequently shortens the minimum period, other Member States will follow because of level playing field considerations. Ultimately, this may induce ‘a race to the bottom’ to the detriment of health and environmental interests. The other way around, safety concerns etc. may lead to a race to the top with very long periods before liability can be shifted (if national liability laws are very strict, for instance Germany considers 30 years), which increases cost uncertainty for storage site operators dramatically. Both arguments suggest that the transfer of responsibility should be fully fixed by legislation. On the other hand, one may say that such a practice does not take into account differences between storage sites, which drive the need for variable periods before responsibility is transferred from storage operators to the competent authority. However, climate and safety risk differences between storage sites are expected to be limited since storage operators have to prove permanent and complete containment of CO_2 in the storage facility already before obtaining a storage permit. Hence, it is advised to standardize the length of the transfer of responsibility period.

The assessment phase of a storage site should be very rigorous. This step will provide authorities with most of the information needed to decide on the safety of a storage site and on the chances that CO_2 will or will not leak. Based on this information authorities should expect an eventual successful transfer of responsibility. Twenty monitoring years are useful to the extent that they provide an indication of whether the situation is under control just after injection has ceased, and no major incidents did occur during injection or closure. However, it will not likely provide much more insight on the chances of leakage for the next period, which chances are some orders of magnitude larger. All in all, the monitoring period is not superfluous for the assessment taking place before the transfer of responsibility.

Finally the CCS Directive is about permanent storage of CO_2. The term ‘permanent’ seems to impose a standard of rigor on characterization and assessment that is not realistic in any scientific field. A solution could be to define a time horizon to qualify the word ‘permanent’. It is recommended to prescribe research based on a definition of a time horizon before which no leakage should occur. This means that the modeling exercises must at least encompass this

time horizon. The definition of the time horizon is a political matter, somehow balancing HSE and the desire to store CO_2.

5. Issue #4: Uncertainties with regard to the long-term liabilities

Uncertainties with regard to the long-term liabilities might become an obstacle for the development of large-scale CCS. Different liability regimes apply to CCS, depending on the type of damage that might occur. The leakage of CO_2 from the CCS chain may cause physical damage to: 1) the global climate system, 2) the environment and ecosystems, 3) human health and materials. When looking at the long-term liability for possible damage caused by CCS, we see that there are three applicable regimes: climate liability, environmental liability and the existing national liability regimes for damage towards third parties.

Table 3: Applicable regimes to damage due to leakage of gaseous CO_2 from the CCS chain

Damage to:	Liabilities covered under	Liable person	Plaintiff
Climate	EU-ETS	Licensee (operator)	Competent Authority (Dutch emissions authority)
Health & Property (third parties)	Dutch Civil Code	Licensee (Operator)	Third parties that suffered the damage
Environment	ELD Directives as implemented in the Dutch environmental management act.	Licensee (operator)	Government/local authorities

The national system handling liabilities towards third parties is not suitable for dealing with liability for the long-term storage of CO_2:

(1) *Currently there is an endless liability horizon for operators towards third parties*. The three regimes have different liability horizons. The liability horizons for climate liability and environmental liability are limited for companies, because with transfer of responsibility over the storage site the liabilities are also transferred to the competent authority. The liabilities towards third parties based on the national system, however, are not and are in principle endless. Although this is not unique for CCS, in case of a developing market (such as CCS). In case of a developing market (such as CCS), these long horizons might function as an obstacle for potential investors.

(2) *There is uncertainty with regard to which specific liabilities apply to CCS*. The national liability system distinguishes different grounds for liability, each of which has a specific liability horizon, specific damages that might be compensated and different possible defences for the liable party. Which of these liabilities will apply, will be determined by case law in court proceedings after damage has occurred and a court procedure has started. For operators, certainty in advance would be welcome.

(3) *The legal debate is very technical and current case law might follow different directions*. The legal debate regarding damage caused to third parties will be of a highly technical nature, whereby one might question the capability of judges to review these matters. Moreover the case law as developed by the courts does not necessarily follow the same direction, due to judicial freedom. It is in the interest of operators and investors that they can predict the possible liabilities (and insurance or compensation costs) that might exist in order to assess the costs of an incident. The national liability regime might therefore function as an obstacle to the large-scale deployment of CCS.

The long-term liabilities should be managed or be tailor-made for CCS. Options include [8], [9]:

(1) *Private insurance.* Private insurance shifts the risk between parties in the market. There are two problems in using insurance. The first is that private markets are receptive to market failure, which might be solved by using the government as a risk bearer. Furthermore, CCS is hard to insure, due to the long-term nature, the stage of development of the technology and possible gradual occurring damage.

(2) *Liability cap/exemption*. In this case the operator is liable for the amount of the cap, but the damages above this amount is taken on by the government. This instrument is also used in the nuclear energy industry. It should be noted that although the liability cap provides for certainty and predictability for the industry, it might undermine the credibility of CCS in the eyes of the public.

(3) *Liability exemption*. A variation on the liability cap is the liability exemption. This exempts a party from being liable for a given cause of action or injury. It could mean that the injured parties would be left without compensation, or that the government would take on the liability, thereby indemnifying the operator.

(4) *Compensation fund*. The industry makes contributions to a fund that compensates possible damages. The types of damages (repairing leakage, injuries, financial loss) for which compensation is available are regulated and compensation can be required through different proceedings (court, prescribed situations).

For projects that have started, the current regime with all its uncertainties is applicable. For projects that are under development, it would be wise to change the long-term liability regime. One way to do so is to adopt a CCS specific liability article in the Dutch Civil Code that limits the liabilities of operators to a certain timeline. However, in that situation, the uncertainties of the judicial regime remain. In designing an instrument to solve the uncertainties created by the current regime, the following considerations should be taken into account:

- What objective is pursued? Deterrence, risk spreading, lowering or stimulating activities or guaranteeing compensation? And in line with that: who should pay for the damages? Polluters, society?
- Who do we want to make the decision on compensation? Judges, experts, legislator?
- How quickly should the instrument adapt itself to change?

Furthermore, the instrument that will be developed cannot be seen separately from the discussion on the financial security to be provided by operators and the financial contribution needed for the transfer of responsibility to the competent authority. The same types of instruments that may be used to manage long-term liability might also be used for the financial security and compensation, although the scope of the latter arrangements is different.

6. Issue #5: Accuracy of monitoring technologies is not laid down in the CCS Directive

The Directive describes the assessment which should take place to guarantee complete and permanent containment of CO_2 in storage facilities, but does not prescribe any particular monitoring technology. Because the monitoring method applied influences the storage costs of the operator, this might cause unfair competition for location of CO_2 storage across EU Member States if monitoring is given different interpretations by several Member States. However, the recent CCS monitoring and reporting guidelines for the Emission Trading System provide more direction on the way monitoring and reporting of emissions of greenhouse gas in the CCS chain should be carried out. As leakage is included as one of the potential sources of CO_2 emissions, this guideline does also include emission quantification rules for leakage from storage sites. Leakage of a storage complex has to be quantified with a maximum total uncertainty of ±7.5%. If the uncertainty is above ±7.5%, the 'excess' uncertainty with respect to ±7.5% requirement has to be added to the reported greenhouse gases. Note, that it is up to the operator to prove the overall uncertainty he claims for the results, which in itself will require non-trivial numerical 'experimenting'.

This method seems fair, as it helps to keep monitoring costs to an acceptable level for emissions that will probably not occur. And from the other side it keeps the uncertainty of the emission in line with uncertainty generally required in the MRG for emission accounting under ETS. Stricter requirements seem not necessary as a higher accuracy in emission estimates will imply higher costs. Furthermore, the EC guidelines narrow the scope for unfair competition for location of CO_2 storage across the EU. Therefore, this issue has been resolved.

7. Issue #6: Third party access (TPA) to CO_2 infrastructure

The number of CO_2 storage facilities available in a specific Member State may be quite limited due to geological conditions. Besides, the number of storage sites to be developed as well as CO_2 transport pipelines connecting CO_2 emitters to storage may be limited due to the high capital intensity of building new storage facilities and pipelines, implying substantial economies of scale. The latter impedes duplication of CO_2 infrastructure by investments of new users. Access to CO_2 infrastructure may become a condition for the building of major point emitters like power plants. Hence, potential electricity generators should be able to obtain access to existing pipeline and storage facilities. Article 21 (2) states that 'The access … shall be provided in a transparent and non-discriminatory manner determined by the Member State'. This implies that third parties should have at least the possibility to negotiate access to the CO_2 infrastructure. However, Member States have the discretion to choose their own regime of third party access (TPA) to the CO_2 infrastructure. They may go beyond purely negotiated access. In case of negotiated access, potential users have to negotiate on the conditions for connection and use-of-system services. In case of regulated access, a regulator is allowed to set conditions for connection and use-of-system services, tariff structures and tariff levels. Generally, in case of negotiated access, stakeholders negotiate the conditions of access themselves, and have recourse to an ex-post competent authority, while in case of regulated TPA the regulator is mainly involved ex-ante. There are different approaches with respect to the developments on TPA. Further research on TPA is needed in order to weigh all arguments for and against more specific regulation on the access arrangements, related to the development of a potential market for CCS.

8. Issue #7: Uncertainty on the type of financial security and on the amount of financial contribution is an obstacle for the industry to invest in CCS

In order to attract CCS industry some Member States might take on more of the possible costs and risks, whereas in other Member States the thresholds might be formulated more rigorously when they do not want to stimulate CCS. The level playing field might be at risk in formulation the elements of the financial mechanism. The EU commission has issued guidelines on the financial security and financial contribution. The document defines different categories of costs and determines whether or not these costs should be included in either the financial security or the financial contribution. Further research is needed on the type and amount of financial security and financial contribution in relation to the existing long-term liabilities for CCS. The central questions in the discussion are:

- To which degree should financial certainty be proven in advance?
- Should the industry be financially responsible for the larger and more unknown events that might occur?
- Which type of security is reasonable?

9. Issue #8: A suitable and effective supervisory structure still has to be designed

The CCS Directive states that 'in cases of trans-boundary transport of CO_2, trans-boundary storage sites or trans-boundary storage complexes, the competent authorities of the Member States concerned shall jointly meet the

requirements of this Directive and of other relevant Community legislation'. It seems likely that the division of responsibilities between Member States will sometimes evolve in cross-border disputes. Whether consultation between Member States is enough for solving possible cross-border disputes regarding CO_2 transport remains to be seen. Relevant questions are:

- Which type of supervisory organization is best suitable for CCS permitting and safety?
- Should there be some kind of structure which enables international cooperation between these supervisors'?

10. Conclusions and discussion

The EU Directive on the Geological Storage of Carbon Dioxide (2009) will have to be transposed into Dutch legislation, mainly by means of adaptation of the Dutch Mining Act. There are, however, a number of issues in the implementation of this Directive that deserve further clarification.

In general, it is not yet clear whether there is a significant risk of leakage, and if this risk exists, whether health, safety, and environment (HSE) risks are significant as well. Furthermore, the Directive does not include clear standards for the fraction of CO_2 that might be at risk to leak from a storage site, offering Member States some discretionary powers in their assessments of storage site selection. With regard to the probability of leakage of CO_2 from a CO_2 storage site, it is recommended to declare a storage site unsafe if:

- No clear-cut reason can be found for simulations of the storage site producing CO_2 leakage;
- A clear-cut reason can be found, with essential parameters being highly uncertain..

With regard to composition of the CO_2 stream and impacts of 'overwhelmingly CO_2', it is concluded that current CO_2 capture processes are well capable of fulfilling the requirements from of meeting restrictions regarding transport and storage systems, as well as health, safety & environment (HSE) considerations. At different stages in the process cleaning techniques will have to be applied. The main motivation for this additional cleaning will be the prevention of corrosion and two-phase flow formation. Since these concerns are of direct interest to the operators of the capture, compression and transport facilities, the requirements in the CCS directive do not necessarily have to be made more specific in this respect.

The CCS Directive requires that a minimum period has elapsed before the responsibility for the storage site can be shifted from the operator to the competent authority. In principle the length of the required minimum period is 20 years, but national competent authorities are allowed to reduce the period before transfer of responsibility can take place. This is the case, when the authority is convinced that the stored CO_2 will be completely and permanently contained before the end of a shorter period. One may set a minimum time below which no transfer of responsibilities is allowed. It is recommended to prescribe research based on a definition of a time horizon before which no leakage should occur. This means that the modeling exercises must at least encompass this time horizon. The definition of the time horizon is a political matter, somehow balancing HSE and the desire to store CO_2.

The leakage of gaseous CO_2 from the CCS chain may cause physical damage to: 1) the global climate system; 2) the environment and ecosystems; 3) third parties (relating to the direct damage to human health due to the exposure to CO_2) and materials. When looking at long-term liability, there are three applicable regimes: climate liability, environmental liability and national liability regimes for damage towards third parties. Currently there is no liability horizon for operators towards third parties. The legal debate is very technical and current case law might be following different directions. For projects that have started already, the current regime with all its uncertainties is applicable. For projects that are in development, it would be wise to change the long-term liability regime. One way to do so, is to adopt a CCS specific liability article in the Dutch Civil Code that limits the liabilities of operators to a certain timeline.

The Directive describes the assessment which should take place to guarantee complete and permanent containment of CO_2 in storage facilities, but does not prescribe any particular monitoring technology. Leakage of a storage complex has to be quantified with a maximum total uncertainty of ±7.5%. If the uncertainty is above ±7.5%, the 'excess' uncertainty with respect to ±7.5% requirement has to be added to the reported greenhouse gases. This method seems fair, as it helps to keep monitoring costs to an acceptable level for emissions that will probably not occur. And from government and society perspective it keeps the uncertainty of the emission in line with uncertainty generally required in the MRG for emission accounting under ETS. Furthermore, the EC guidelines narrow the scope for unfair competition for location of CO_2 storage across the EU.

The CCS Directive provides that third parties should be provided access to transport networks and storage sites in a transparent and non-discriminatory manner. This implies that third parties should have at least the possibility to negotiate access to the CO_2 infrastructure. However, it may be that the market structure for large scale CCS requires a more regulated form of TPA in the medium or long term. More research is needed on the suitability of the different possible access regimes.

Action should preferable be taken at European level by more strict legislation in the short term. As such legislation is foreseen by 2015 at the earliest, national policy makers should take action in the short term. The problem is that potential users are competitors in electricity generation (since they are vertically integrated), which implies that a storage owner has an incentive to restrict third-party access to a favorable storage facility (i.e. vertical foreclosure).

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